UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
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SUBJECT: Derivation of RBCs for Carcinogens that Act Via a Mutagenic Mode of Action and Incorporate Default ADAFs

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TO: RBC Table Users

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corrected November 8, 2006*

Because of the special considerations for carcinogens that act via a mutagenic mode of action, this memo includes a demonstration of the assumptions behind the Region III RBCs for those chemicals that incorporate the default age-dependent adjustment factors (ADAFs). A sample calculation for each medium is provided below.

On March 29, 2005, EPA Administrator Stephen Johnson provided general direction on implementing EPA's 2005 Guidelines for Carcinogen Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. This was followed by an announcement in the April 7, 2005 Federal Register, and by the release of additional guidance documents concerning the implementation of the new cancer guidelines.

The aspect of the new guidelines that most directly affects Region III RBCs is the use of ADAFs to adjust cancer risk for receptors whose exposure includes early life. For chemicals that EPA has determined to be carcinogenic via a mutagenic mode of action, special adjustments are applied in estimating cancer risks. Vinyl chloride has a chemical-specific adjustment, described in its IRIS file. The impact of vinyl chloride's adjustment on Region III RBCs was discussed in the May 6, 2001 memo, "Derivation of Vinyl Chloride RBCs," found at http://www.epa.gov/reg3hwmd/risk/human/info/vcrbc.pdf. For the other chemicals, where no chemical-specific ADAFs have been developed, default ADAFs are used: 10 for age 0-2, 3 for age 2-16, and no adjustment for ages 16 and up. These chemicals are now marked with an "m" on the Region III RBC Table.

One example for each medium is provided below. The exposure factors are consistent with the defaults used in the other RBCs.

*The original October 19 version of this memo contained a typographical error in Section 2A: "mg/L" was used instead of "ug/L" for the concentration term in three of the equations. The units have now been corrected.

SAMPLE EQUATIONS - RBCs

1.   Soil, Residential

Sample Chemical: Benzo[a]pyrene
PRG = 0.022 mg/kg

Age 0-2

$$\frac{0.022 \text{ mg/kg x 200 mg/day x 350 days/yr x 2 yrs x 1E-6 kg/mg}}{365 \text{ days/yr x 70 yr x 15 kg}} \times \frac{7.3}{\text{mg/kg/day}} \times 10 = \textbf{5.9E-7}$$

Age 2-6

$$\frac{0.022 \text{ mg/kg x 200 mg/day x 350 days/yr x 4 yrs x 1E-6 kg/mg}}{365 \text{ days/yr x 70 yr x 15 kg}} \times \frac{7.3}{\text{mg/kg/day}} \times 3 = \textbf{3.5E-7}$$

Age 6-16

$$\frac{0.022 \text{ mg/kg x 100 mg/day x 350 days/yr x 10 yrs x 1E-6 kg/mg}}{365 \text{ days/yr x 70 yr x 70 kg}} \times \frac{7.3}{\text{mg/kg/day}} \times 3 = \textbf{9.4E-8}$$

Age 16-30

$$\frac{0.022 \text{ mg/kg x 100 mg/day x 350 days/yr x 14 yrs x 1E-6 kg/mg}}{365 \text{ days/yr x 70 yr x 70 kg}} \times \frac{7.3}{\text{mg/kg/day}} \times 1 = \textbf{4.4E-8}$$

Total Risk
5.9E-7 + 3.5E-7 + 9.4E-8 + 4.4E-8 = 1E-6

2.   Tap water

Sample chemical = Dibromochloropropane (VOC)
PRG = 2E-4 ug/L

A.   Ingestion risk

Age 0-2

$$\frac{0.0002 \text{ ug/L x 1 L/day x 350 days/yr x 2 yrs x 1E-3 mg/ug}}{365 \text{ days/yr x 70 yr x 15 kg}} \times \frac{0.8}{\text{mg/kg/day}} \times 10 = \textbf{2.9E-9}$$

Age 2-6

$$\frac{0.0002 \text{ ug/L x 1 L/day x 350 days/yr x 4 yrs x 1E-3 mg/ug}}{365 \text{ days/yr x 70 yr x 15 kg}} \times \frac{0.8}{\text{mg/kg/day}} \times 3 = \textbf{1.8E-9}$$

Age 6-16

$$\frac{0.0002 \text{ ug/L x 2 L/day x 350 days/yr x 10 yrs x 1E-3 mg/ug}}{365 \text{ days/yr x 70 yr x 70 kg}} \times \frac{0.8}{\text{mg/kg/day}} \times 3 = \textbf{1.9E-9}$$

Age 16-30

$$\frac{0.0002 \text{ ug/L} \times 2 \text{ L/day} \times 350 \text{ days/yr} \times 14 \text{ yrs} \times 1\text{E-3 mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{0.8}{\text{mg/kg/day}} \times 1 = \mathbf{8.8E\text{-}10}$$

Total Ingestion Risk
2.9E-9 + 1.8E-9 + 1.9E-9 + 8.8E-10 = 7.5E-9

B.   Inhalation risk

Age 0-2

$$\frac{2\text{E-4 ug/L} \times 0.5 \text{ L/m}^3 \times 12 \text{ m}^3\text{/dy} \times 350 \text{ dy/yr} \times 2 \text{ yrs} \times 1\text{E-3 mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 15 \text{ kg}} \times \frac{21}{\text{mg/kg/day}} \times 10 = \mathbf{4.6E\text{-}7}$$

Age 2-6

$$\frac{2\text{E-4 ug/L} \times 0.5 \text{ L/m}^3 \times 12 \text{ m}^3\text{/dy} \times 350 \text{ dy/yr} \times 4 \text{ yrs} \times 1\text{E-3 mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 15 \text{ kg}} \times \frac{21}{\text{mg/kg/day}} \times 3 = \mathbf{2.8E\text{-}7}$$

Age 6-16

$$\frac{2\text{E-4 ug/L} \times 0.5 \text{ L/m}^3 \times 20 \text{ m}^3\text{/dy} \times 350 \text{ dy/yr} \times 10 \text{ yrs} \times 1\text{E-3 mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{21}{\text{mg/kg/day}} \times 3 = \mathbf{2.5E\text{-}7}$$

Age 16-30

$$\frac{2\text{E-4 ug/L} \times 0.5 \text{ L/m}^3 \times 20 \text{ m}^3\text{/dy} \times 350 \text{ dy/yr} \times 14 \text{ yrs} \times 1\text{E-3 mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{21}{\text{mg/kg/day}} \times 1 = \mathbf{1.2E\text{-}7}$$

Total Inhalation Risk
4.6E-7 + 2.8E-7 + 2.5E-7 + 1.2E-7 = 1E-6

Total Tap Water Risk
7.5E-9 + 1E-6 = 1E-6

3.   Air

Sample chemical = Benzidine

A.   Dose-Based Method (Using CSF in 1/mg/kg/day)

PRG = 1E-5 ug/m^3

Age 0-2

$$\frac{1\text{E-5 ug/m}^3 \times 12 \text{ m}^3\text{/day} \times 350 \text{ days/yr} \times 2 \text{ yrs} \times 1\text{E-3 mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 15 \text{ kg}} \times \frac{230}{\text{mg/kg/day}} \times 10 = \mathbf{5E\text{-}7}$$

Age 2-6

$$\frac{1E\text{-}5 \text{ ug/m}^3 \times 12 \text{ m}^3/\text{day} \times 350 \text{ days/yr} \times 4 \text{ yrs} \times 1E\text{-}3 \text{ mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 15 \text{ kg}} \times \frac{230}{\text{mg/kg/day}} \times 3 = \textbf{3E-7}$$

Age 6-16

$$\frac{1E\text{-}5 \text{ ug/m}^3 \times 20 \text{ m}^3/\text{day} \times 350 \text{ days/yr} \times 10 \text{ yrs} \times 1E\text{-}3 \text{ mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{230}{\text{mg/kg/day}} \times 3 = \textbf{2.7E-7}$$

Age 16-30

$$\frac{1E\text{-}5 \text{ ug/m}^3 \times 20 \text{ m}^3/\text{day} \times 350 \text{ days/yr} \times 14 \text{ yrs} \times 1E\text{-}3 \text{ mg/ug}}{365 \text{ days/yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{230}{\text{mg/kg/day}} \times 1 = \textbf{1.3E-7}$$

Total Risk
5E-7 + 3E-7 + 2.7E-7 + 1.3E-7 = 1E-6

B. Concentration-Based Method (Using IUR in m^3/ug).

PRG = 1.5E-5 ug/m^3

Age 0-2

$$\frac{1.5E\text{-}5 \text{ ug/m}^3 \times 350 \text{ days/yr} \times 2 \text{ yrs}}{365 \text{ days/yr} \times 70 \text{ yr}} \times \frac{0.067}{\text{ug/m}^3} \times 10 = \textbf{2.8E-7}$$

Age 2-6

$$\frac{1.5E\text{-}5 \text{ ug/m}^3 \times 350 \text{ days/yr} \times 4 \text{ yrs}}{365 \text{ days/yr} \times 70 \text{ yr}} \times \frac{0.067}{\text{ug/m}^3} \times 3 = \textbf{1.7E-7}$$

Age 6-16

$$\frac{1.5E\text{-}5 \text{ ug/m}^3 \times 350 \text{ days/yr} \times 10 \text{ yrs}}{365 \text{ days/yr} \times 70 \text{ yr}} \times \frac{0.067}{\text{ug/m}^3} \times 3 = \textbf{4.1E-7}$$

Age 16-30

$$\frac{1.5E\text{-}5 \text{ ug/m}^3 \times 350 \text{ days/yr} \times 14 \text{ yrs}}{365 \text{ days/yr} \times 70 \text{ yr}} \times \frac{0.067}{\text{ug/m}^3} \times 1 = \textbf{1.9E-7}$$

Total Risk
2.8E-7 + 1.7E-7 + 4.1E-7 + 1.9E-7 = 1E-6

Fish Tissue and Industrial Soil RBCs:
Because these RBC scenarios involve adults only, the ADAFs for early-life exposure do not apply. Therefore, these RBCs are derived in the traditional manner and are not shown in this memo.